# CIRCUIT BREAKER EMPLOYING AN ILLUMINATED OPERATING HANDLE

## CROSS-REFERENCE TO RELATED APPLICATION

This application is related to commonly assigned, concurrently filed United States Patent Application Serial No. __/_____, filed _____ ___, 2003, entitled "Circuit Breaker Employing Illuminating Indicators for Open and Closed Positions" (Attorney Docket No. 03-EDP-179).

## BACKGROUND OF THE INVENTION

### Field of the Invention

This invention relates generally to circuit breakers and, more particularly, to circuit breakers including an operating mechanism and an operating handle.

### Background Information

Circuit breakers are disclosed, for example, in U.S. Patent Nos. 3,329,913; 3,955,162; 4,151,386; 4,267,539; 4,926,148; and 4,963,847.

Hydraulic and electromagnetic circuit breakers typically comprise a movable contact, which is mounted on a movable arm, and a fixed or stationary contact. An operating handle is coupled to the movable arm via a linkage mechanism, part of which comprises a collapsible toggle assembly. The movable and stationary contacts are operated between contacts "open" and contacts "closed" positions by pivoting the operating handle. The circuit breaker further comprises a hydraulic or electromagnetic device which, in response to one or more predetermined electrical conditions, collapses the toggle assembly to a broken state, in order to trip "open" the separable movable and stationary contacts. Typically, the operating handle assumes one of two or three positions (*e.g.*, "on", "off" and "tripped") corresponding to the contacts "closed" position, contacts "open" position, and contacts tripped "open" position.

Users who apply circuit breakers in relatively dark enclosures or other relatively dark environments desire a relatively quicker and more efficient mechanism than, for example, employing fixed or portable enclosure lighting for identifying when a circuit breaker has been turned off or tripped. Otherwise, there is a "guessing

game" of whether a circuit breaker is in the "on" position versus the "off" or tripped "off" position(s).

Accordingly, there is room for improvement in circuit breakers.

## SUMMARY OF THE INVENTION

These needs and others are met by the present invention, which provides two illuminable indicators to indicate: (1) the "on" position (contacts "closed"); and (2) the "off" or tripped "off" positions (contacts "open" or contacts tripped "open" positions). Those indicators, in turn, are employed to illuminate the circuit breaker operating handle. Accordingly, this gives users, such as maintenance personnel, an instant indication of the circuit breaker status without having to employ, for example, fixed or portable enclosure lighting. Therefore, this permits the user to immediately locate the interrupted or otherwise opened circuit, and to reset or close the appropriate circuit breaker.

In accordance with the invention, a circuit breaker comprises: a housing including an opening; separable contacts within the housing; an operating mechanism for opening and closing the separable contacts, the operating mechanism including an operating handle having a portion protruding through the opening of the housing; means for providing a first output when the separable contacts are open and a second output when the separable contacts are closed; a first indicator cooperating with the first output of the means for providing, the first indicator being proximate the operating handle and being illuminated when the separable contacts are open; and a second indicator cooperating with the second output of the means for providing, the second indicator being proximate the operating handle and being illuminated when the separable contacts are closed, wherein one of the first and second indicators illuminates the operating handle.

The means for providing may include an auxiliary switch cooperating with the operating mechanism, the auxiliary switch having the first output and the second output.

The first indicator may be a first LED, and the second indicator may be a second LED.

The opening of the housing may include a first end and a second end. The operating handle may include a first position and a second position. The portion

of the operating handle may include a first side proximate the first end of the opening in the first position and a second side proximate the second end of the opening in the second position. The first indicator may be disposed proximate the first end of the opening and proximate the first side of the operating handle in the first position thereof. The second indicator may be disposed proximate the second end of the opening and proximate the second side of the operating handle in the second position thereof.

The means for providing may include an auxiliary switch having an operating member cooperating with the operating mechanism, a common terminal, a normally closed terminal providing the first output and a normally open terminal providing the second output.

The first indicator may be a first LED including a first cathode and a first anode, and the second indicator may be a second LED including a second cathode and a second anode, which is electrically connected to the first anode of the first LED.

The opening of the housing may be a first opening. The housing may be a case including a second opening and a third opening. The first indicator may be a first LED, which protrudes through the second opening of the case. The second indicator may be a second LED, which protrudes through the third opening of the case. The first opening of the housing may include a first end and a second end. The operating handle may include a first position and a second position. The portion of the operating handle may include a first side proximate the first end of the first opening in the first position and a second side proximate the second end of the first opening in the second position. The first LED may be disposed proximate the first end of the first opening and proximate the first side of the operating handle in the first position thereof. The second LED may be disposed proximate the second end of the first opening and proximate the second side of the operating handle in the second position thereof.

The operating handle may be generally transparent and may include a first recess receiving a portion of the first LED in the first position and may include a second recess receiving a portion of the second LED in the second position.

## BRIEF DESCRIPTION OF THE DRAWINGS

A full understanding of the invention can be gained from the following description of the preferred embodiments when read in conjunction with the accompanying drawings in which:

Figure 1 is a vertical elevation view of a circuit breaker incorporating the present invention, with one-half case being removed to show the general internal arrangement and to illustrate the separable contacts in the closed position.

Figure 2 is a vertical elevation view, which is similar to Figure 1, except with the separable contacts in the open position.

Figure 3 is an isometric view of the operating handle of Figure 1.

Figure 4 is a schematic diagram showing the auxiliary switch, the LEDs, the printed circuit board electrical connections and the resistor of Figure 1.

Figure 5 is a plan view of the circuit side of the printed circuit board of Figure 1.

Figure 6 is a plan view of the component side of the printed circuit board of Figure 1.

Figure 7 is an isometric view showing the operating handle in the open position and one of the LEDs of Figure 1.

Figure 8 is an isometric view showing the operating handle in the closed position and one of the LEDs of Figure 1.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figures 1 and 2, the invention will be described as applied to a circuit breaker 10 for use in direct current (DC) telecommunication systems (*e.g.*, 60 VDC; 65 VDC; 80 VDC). It will become evident that the invention is applicable to other types of circuit breakers including those used in alternating current (AC) systems operating at various frequencies; to relatively smaller or larger circuit breakers, such as subminiature or miniature circuit breakers; and to a wide range of circuit breaker applications, such as, for example, residential, commercial, industrial, aerospace, and automotive. As further non-limiting examples, both AC (*e.g.*, 110, 120, 220, 240, 480-600 VAC) operation at a wide range of frequencies (*e.g.*, 50, 60, 120, 400 Hz) and DC operation (*e.g.*, 42, 60 VDC) are possible.

The circuit breaker 10 is generally similar to ones disclosed in U.S. Patent Nos. 3,955,162 and 4,926,148, for example, which are hereby incorporated by reference herein. The circuit breaker 10 includes an insulating housing 11 formed by abutting half-cases, such as 12 (the other half-case is not shown), an operating handle 22, and terminals 34 and 36 for connecting the circuit breaker 10 to a load (not shown). The breaker operating mechanism, generally designated 14, includes a frame 16 mounted on the housing 11 and various linkages rotatably supported thereon. An actuatable member 18 is moved by an internal actuator 20 attached to the operating handle 22 , wherein it is rotatably supported relative to the housing 11. The operating handle 22 also has an external portion 19 protruding through an opening 23 of the housing 11. At the other end of the housing 11 is a movable contact support 24 carrying a movable breaker contact 26 pivotally supported to rotate about a pin 28 on the frame 16. The movable contact support 24 is joined to an actuator linkage mechanism 29 by a pin 30, which allows the movable contact support 24 to be moved down (with respect to Figure 2), in order that the movable breaker contact 26 closes against a fixed breaker contact 32 as shown in Figure 1. The fixed contact 32 is supported on the housing half-case 12 and is electrically connected to the external terminal 34. As is discussed below, the movable contact 26 is electrically connected through a conductive circuit to the other external terminal 36. These external terminals 34,36 are the mechanism by which the breaker 10 is electrically connected into a protected circuit (not shown).

The housing 11 supports a switch receptacle 38. The half-case 12 is molded integrally with one half of the auxiliary receptacle 38 of the same resinous material. Similarly, the other half of the receptacle (not shown) is molded integrally with the other half-case (not shown). The half-cases mate to form the completed receptacle 38 when the breaker half-cases are assembled. The receptacle 38 is provided with recesses, such as 40, preferably conforming to the shape and size of an auxiliary switch 42.

The auxiliary switch 42 includes an operating member, such as a spring-loaded switch actuator, such as plunger 44. A spring (not shown) urges the plunger 44 into an extended position as shown in Figure 2, representing one condition of the auxiliary switch 42, which corresponds to the open position of the separable

contacts 26,32. When depressed inwardly against the loading of its internal spring, the plunger 44 produces the other condition of the auxiliary switch 42, which corresponds to the closed position of the separable contacts 26,32 of Figure 1. Between the plunger 44 and the movable contact support 24 of the operating mechanism 14, and more specifically a surface 24a thereof, is a pivotally mounted auxiliary switch actuator member 46. The auxiliary switch actuator member 46 is designed to be moved into the plunger 44, in order to change the auxiliary switch condition. In this embodiment, the spring of the plunger 44 will return such plunger and the actuator member 46 to its rest position of Figure 2 when the movement of the operating mechanism 14 permits.

Pivotally connected to the handle 22 is the linkage 29. The movable contact support 24 is pivotally connected to the linkage 29. The handle 22, the linkage 29 and the movable contact support 24, together with an electromagnetic tripping device or sensing element 87, jointly comprise the operating mechanism 14 of the circuit breaker 10.

The linkage 29, which includes a first link 29a and a second link 29b, is pivotally connected at its lower (with respect to Figures 1 and 2) end to the movable contact support 24 and at its upper (with respect to Figures 1 and 2) end to the handle 22.

For locking the linkage 29 in the overcenter position during automatic resetting, the linkage 29 includes a latch mechanism comprising a spring biased latch 56 carried by the second link 29b. The latch 56 is tripped by a pivotal armature 60 having three legs, namely, a first or unlatching leg 62, a second or attractable leg 64 and a third or substantially balancing leg (not shown). The unlatching leg 62 engages (as shown in phantom line drawing in Figure 1) the latch 56 and turns it (counter-clockwise with respect to Figures 1 and 2) to unlatch the linkage 29, thereby allowing the linkage 29 to collapse under the bias of the opening spring 65 (Figure 2) when the attractable leg 64 is pivoted sufficiently toward the pole piece 70 of an electromagnet 72 (upon predetermined overload) to bring the unlatching leg 62 into engagement with the latch 56. Further, the armature 60 pivots about a pin 61 carried by the frame 16.

The electromagnet 72 comprises a solenoid coil 74 about a tube 76, the latter projecting through a first leg 78 of the frame 16. The second frame leg 79 extends longitudinally along the coil 74, as shown. The tube 76 is of non-magnetic material and houses a movable core (not shown) of magnetizable material biased by a spring (not shown) disposed toward the lower (with respect to Figures 1 and 2) end of the tube 76. The moveable core is retarded in its upward (with respect to Figures 1 and 2) movement by a liquid, preferably a silicone oil, within the tube 76 to provide a time delay below certain overload currents before tripping of the circuit breaker 10 takes place. The coil 74 has one end connected to the movable contact support 24 by a flexible conductor 84 and the other end connected by a conductor 86 to the terminal 36. Thus, the electromagnetic tripping device or sensing element 87 is formed by the coil 74, the tube 76, the movable core within the tube 76, and the armature 60 for tripping the circuit breaker 10 after a time delay period at certain overloads or substantially instantaneously at higher overloads.

Figures 1 and 2 show the closed and open positions, respectively, of the operating mechanism 14, the operating handle 22 and the separable contacts 26,32. In the present circuit breaker 10, the tripped open position of the operating handle 22 is the same as the open position thereof. Alternatively, the invention is applicable to a circuit breaker (not shown) in which in a third, or tripped open position, the operating handle thereof is intermediate the on and off positions of Figures 1 and 2. Regardless, for the tripped open position, the linkage 29 is broken (not shown) by operation of the latch 56 and the electromagnetic tripping device or sensing element 87.

In accordance with the present invention, as shown in Figures 1, 2 and 4, a circuit 100 (Figure 4) includes the auxiliary switch 42 and a printed circuit board (PCB) 102 (as best shown in Figures 5 and 6) having a resistor 104. The circuit 100 provides a first output 106 when the separable contacts 26,32 are open (Figure 2) (or tripped open) and a second output 108 when such separable contacts are closed (Figure 1). A first indicator (*e.g.*, an LED 110 having a first color, such as green) cooperates with the first output 106, is proximate the operating handle 22 and is illuminated when the separable contacts 26,32 are open. A second indicator (*e.g.*, an LED 112 having a second color, such as red) cooperates with the second output 108,

is proximate the operating handle 22 and is illuminated when the separable contacts 26,32 are closed. One of the first and second LEDs 110,112 illuminates the operating handle 22 (as best shown in Figure 3). The printed circuit board 102 is suitably conformally coated with a suitable insulator, in order to electrically insulate the conductive traces thereon from internal conductive structures of the circuit breaker 10. Also, a suitable insulator (*e.g.*, RTV) is disposed on any other exposed conductive surfaces (*e.g.*, solder connections; resistor leads).

Continuing to refer to Figure 4, the auxiliary switch 42 includes a common terminal 114, a normally closed (NC) terminal 116 providing the first output 106 and a normally open (NO) terminal 118 providing the second output 108. The common terminal 114 of the auxiliary switch 42 is adapted to receive a common 120 from a power source, such as a power supply 122 (shown in phantom line drawing), external to the circuit breaker 10 of Figures 1 and 2. In addition to the auxiliary switch common terminal 114, the first and second LEDs 110,112 include respective terminals, such as anode leads 124,126, which are adapted to be energized through the PCB 102 and the resistor 104 from the external power supply 122. As was discussed above in connection with Figures 1 and 2, the actuator member 46 engages and actuates the auxiliary switch plunger 44 in the closed or "on" position of the separable contacts 26,32 and is typically disengaged from such plunger in the open or "off" or tripped "off" position of such separable contacts.

As shown in Figures 1, 2 and 7, proximate the ends 128,130 of the operating handle opening 23 of the housing 11 are openings 132,134 (*e.g.*, 3 mm) for the respective LEDs 110,112, which protrude through those respective openings.

As shown by Figures 3, 7 and 8, the operating handle 22, which is preferably generally transparent, includes a first recess 136 receiving a portion of the first LED 110 in the open position of the operating handle 22 (Figures 2 and 7) and includes a second recess 138 receiving a portion of the second LED 112 in the closed position of the operating handle 22 (Figures 1 and 8).

Alternatively, in the event that a circuit breaker (not shown) employs an operating handle with an intermediate tripped open position, in that position, the first LED 110 would be set apart from, but would still generally illuminate the first recess 136 of the operating handle 22.

Figure 4 shows the auxiliary switch 42, the LEDs 110,112 and the PCB 102, which electrically connects together the LED anode leads 124,126. The leads 124,125 of the LED 110 and the leads 126,127 of the LED 112 are directly electrically connected (or indirectly electrically connected through suitable conductors (not shown)) to plated-through component openings 140,142 and 144,146, respectively, of the PCB 102 (Figures 5 and 6). In turn, the PCB 102 electrically connects the component opening 142 and, thus, the cathode lead 125 of LED 110 to a plated-through component opening 148 by conductive trace 149, and electrically connects the component opening 146 and, thus, the cathode lead 127 of LED 112 to a plated-through component opening 150 by conductive trace 151. Also, two conductive traces 152,153 electrically connect the component openings 140,144 and, thus, the common LED anode leads 124,126 to a plated-through component opening 154 for the resistor 104. Another component opening 156 for the resistor 104 is electrically connected by a conductive trace 157 to a plated-through component opening 158. The component side (Figure 6) of the printed circuit board 102 and the traces thereon are a mirror image of the circuit side (Figure 5), except that the resistor 104, of course, is hidden from view in Figure 5.

A first conductor 160 from the component opening 148 is electrically connected to the switch NC terminal 116. A second conductor 162 from the component opening 150 is electrically connected to the switch NO terminal 118. The switch common terminal 114 is electrically interconnected by a third conductor 164 with the common 120 of the power source 122. The component opening 158 is electrically interconnected by a fourth conductor 166 with a voltage 168 of the power source 122. Preferably, the conductors 160, 162, 164, 166 are electrically insulated. Alternatively, the conductors 164,166 may include suitable terminations (not shown) for suitable electrical connection to the external power source 122.

In this manner, the LED anode leads 124,126 are electrically connected by the printed circuit board traces 152,153 to the resistor 104, which is electrically energized by the power supply voltage 168 through the conductive trace 157, the component opening 158 and the conductor 166. The cathode lead 125 of the first LED 110 is electrically connected through the PCB 102 by the trace 149, the component opening 148 and the conductor 160 to the switch NC terminal 116. The

cathode lead 127 of the second LED 112 is electrically connected through the PCB 102 by the trace 151, the component opening 150 and the conductor 162 to the switch NO terminal 118.

Figure 7 shows the illuminated operating handle 22 in the open position along with the second LED 112, which is not illuminated. In this position, the first LED 110 (Figure 8) is illuminated and engages the first operating handle recess 136 (as best shown in Figure 3). Conversely, Figure 8 shows the illuminated operating handle 22 in the closed position along with the first LED 110, which is not illuminated. In this position, the second LED 112 (Figure 7) is illuminated and engages the second operating handle recess 138 (as best shown in Figure 3).

The exterior portion 19 of the operating handle 22 of Figure 3 includes a first side 173 proximate the first end 128 of the housing opening 23 in the open position, and a second side 175 proximate the second end 130 of that opening in the closed position. The first LED 110 (as shown in Figure 8) is disposed proximate (in Figure 7) the first end 128 of the opening 23 and proximate the operating handle first side 173 in the open position. The second LED 112 (as shown in Figure 7) is disposed proximate (in Figure 8) the second end 130 of the opening 23 and proximate the operating handle second side 175 in the closed position. In this manner, in either of those positions, one of the LEDs 110,112 is illuminated and engages the corresponding one of the recesses 136,138, respectively, and thus, illuminates the operating handle 22.

The two individual LEDs 110,112 are located on opposite sides of the clear operating handle 22 (*e.g.*, made of Lexan® polycarbonate). The auxiliary switch plunger 44 toggles the auxiliary switch 42, which provides the two outputs 106,108 to the respective LEDs 110,112. The first green LED 110 illuminates when the circuit breaker 10 is "tripped" or "off", and the second red LED 112 illuminates when the circuit breaker 10 is "on". As the circuit breaker 10 is toggled between "off" (or the tripped "off") and the "on" positions, the LEDs 110,112 are toggled back and forth between the green light and the red light.

Alternatively, the operating handle 22 may be opaque (not shown) and two indicators (not shown) may be employed to illuminate corresponding exterior portions of such operating handle.

Although individual LED indicators 110,112 are disclosed, the invention is applicable to any suitable indicator(s), which may be suitably illuminated to show the open and closed positions of separable contacts, such as 26,32, and, in turn, to illuminate a circuit breaker operating handle. For example, any suitable illuminable indicator(s) and combinations thereof may be employed (*e.g.*, a dual indicator; two individual indicators; lamp(s), light(s); any suitable illuminating device(s)).

Alternatively, a different auxiliary switch (not shown) may be employed to output to the LED indicator 110 when the separable contacts 26,32 are tripped open, and to output to the LED indicator 112 when the separable contacts are not tripped open (*e.g.*, open or closed) with the linkage 29 being unbroken.

In the exemplary embodiment, the first indicator 110 has a first color (*e.g.*, green; any suitable color), and the second indicator 112 has a second different color (*e.g.*, red; any suitable color). It will be appreciated that these colors may be swapped or that a wide range of suitable colors may be employed. Alternatively, one of the indicators 110,112 may employ a suitable color, and the other one of the indicators 110,112 may employ the same suitable color, which is illuminated with a suitable on/off modulation by a suitable circuit (not shown). Alternatively, a single indicator (not shown) may be employed which is illuminated in a suitable color for one of the "on" and "off" positions, and is illuminated in the same suitable color with a suitable on/off modulation by a suitable circuit (not shown) for the other one of the "on" and "off" positions. Alternatively, a third indicator may be employed for the tripped "off" position.

Although a circuit 100 including an auxiliary switch 42 providing the outputs 106,108 is disclosed, any suitable circuit and/or mechanism may be provided in order to provide outputs corresponding to the open and closed states of separable contacts.

Although an external power source 122 is shown, the invention is applicable to circuit breakers employing a suitable internal power source (not shown).

Although the resistor 104 is employed between the common LED anodes 124,126 and the power supply voltage 168, the invention is applicable to

circuits which employ a resistor between common LED cathodes and the power supply common 120.

Although a single pole circuit breaker 10 is disclosed, the invention is applicable to circuit breakers and other electrical switching devices having any count of poles and with or without a suitable trip mechanism (*e.g.*, hydraulic; electromagnetic; magnetic; thermal).

While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the invention which is to be given the full breadth of the claims appended and any and all equivalents thereof.